Raquel Noriega
Director
Federal Regulatory

AT&T Services Inc.
1120 20th Street, NW Suite 1000
Washington, DC, 20036

+1.202.457.2141
raquel.noriega@att.com

June 6, 2019

EX PARTE VIA ELECTRONIC FILING

Marlene Dortch
Secretary
Federal Communications Commission
445 12th St., SW
Washington, DC 20554

Re: Expanding Flexible Use of the 3.7 to 4.2 GHz Band, GN Docket No. 18-122

Dear Ms. Dortch,

On June 5, 2019, Hank Hultquist, Navid Motamed, Neeti Tandon, Michael Goggin, Alex Starr, Wilson Scarbeary, Raquel Noriega, and joining by telephone, David Wolter, of AT&T Services, Inc. (AT&T) met with Donald Stockdale, Becky Schwartz, Blaise Scinto, Thomas Derenge, Anna Gentry, Jeffrey Tignor, Peter Daronco and Joel Taubenblatt of the Wireless Telecommunications Bureau, Kerry Murray of the International Bureau, Evan Kwerel, Giulia McHenry, Paul Lafontaine, Patrick DeGraba and Nicholas Copeland of the Office of Economic Analysis, and Michael Ha and Gregory Callaghan of the Office of Engineering and Technology. Paul Powell, Joyce Jones, and Brian Wondrack of the Wireless Telecommunications Bureau, and Jennifer Gilsenan and Paul Blais of the International Bureau joined the meeting via telephone.

The discussion centered on the attached presentation, which summarizes and highlights the matters addressed in AT&T's *ex parte* letter dated May 23, 2019,[1] which is also attached. In addition, AT&T urged the Commission to release promptly a Public Notice seeking further information regarding key technical engineering matters relevant to the policy and legal issues raised in this proceeding, including but not limited to those examined in this letter's attachments. Although the Notice of Proposed Rulemaking in this proceeding generally encompasses such matters,[2] the record has not developed to the degree necessary to permit the Commission to

[1] Letter dated May 23, 2019 from Henry Hultquist, AT&T, to Marlene Dortch, FCC, GN Docket No. 18-122.
[2] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Order and Notice of Proposed Rulemaking, 33 FCC Rcd 6915 (2018) (NPRM).

engage in reasoned decision-making; and given the passage of time since release of the NPRM (i.e., almost twelve months), there is good cause to believe that such record will not develop organically without further Commission encouragement. Accordingly, AT&T expressed the need for the Commission to expeditiously issue a Public Notice seeking "focused additional comment" on the myriad of technical engineering questions that remain inadequately addressed in the current record. Moreover, AT&T noted that there are other important issues in this proceeding that remain inadequately developed in the record, and AT&T looks forward to working with the Commission and other stakeholders to fill these gaps.

Please contact me if you have any questions related to these matters.

Sincerely,

/s/
Raquel Noriega

cc:
Donald Stockdale, WTB
Evan Kwerel, OEA
Paul Lafontaine, OEA
Patrick DeGraba, OEA
Nicholas Copeland, OEA
Giulia McHenry, OEA
Becky Schwartz, WTB
Paul Powell, WTB
Blaise Scinto, WTB
Paul Blais, IB
Joyce Jones, WTB
Jennifer Gilsenan, IB
Brian Wondrack, WTB
Kerry Murray, IB
Thomas Derenge, WTB
Anna Gentry, WTB
Jeffrey Tignor, WTB
Peter Daronco, WTB
Joel Taubenblatt, WTB
Michael Ha, OET
Gregory Callaghan, OET

C-Band Radio Frequency Management

June 5, 2019

AT&T

AT&T Builds on CBA's Proposal to Achieve Higher Spectral Efficiency

AT&T has analyzed the C-Band Alliance (CBA) proposal for radio frequency (RF) management in the C-band and concludes that CBA's proposal should be modified to achieve more spectral efficiency in the cleared 5G band while still ensuring full protection of FSS earth stations

In particular, AT&T proposes that

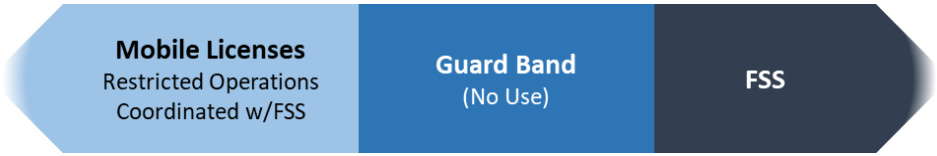
- there should be no fallow guard band;
- terrestrial licenses that are sufficiently spectrally distant from the FSS edge should be allowed to operate at full power with no requirements to coordinate with FSS earth stations;
- lower power and/or coordination requirements would apply only to terrestrial licenses in an Adjacent Block immediately below the FSS edge to ensure protection of FSS earth stations.

Additionally, CBA's proposals should be further examined to ensure rules are designed to achieve maximum spectral efficiency of 5G deployment while appropriately protecting FSS earth stations including

- 5G base station out of band (OOB) emission limits;
- 150 m protection zone around registered earth stations;
- aggregate interference environment;
- FSS full arc coordination requirements;
- telemetry, tracking & control protection zones; and
- user equipment OOB emission limits

CBA's Technical RF Management Proposal

CBA's Proposal



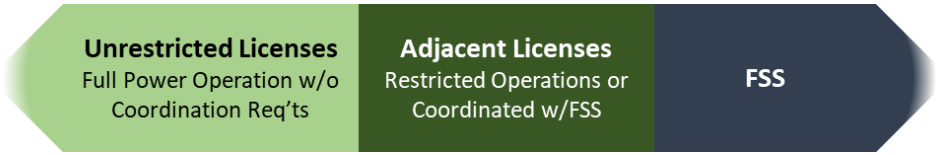
- Requires 20 MHz of guard band and proposes all licenses in the proposed terrestrial block would be subject to lower power and coordination requirements with 17,000+ registered FSS earth stations
- Proposes aggregate RF power density at the output of a reference RF filter and antenna of a FSS earth station produced by emissions from all fixed and base stations of a 5G licensee within 40 km radius of an FSS earth station
- Proposes that in-band emissions RF power density "shall not exceed a value of -81.6 dBm/MHz in the band 3700-3900 MHz"
- Proposes that OOB emissions in the FSS band RF power density "shall not exceed a value of -133 dBm/MHz for earth stations used for satellite [TT&C] operations and -128 dBm/MHz for other earth stations"
- Proposes these protection requirements must be complied with "for any pointing of the antenna towards the [GSO] arc with an elevation angle greater than or equal to 5 degrees" and "for all earth station antennas within a radius of 150 meters of the location of the registered earth station"
- Additionally, proposes 4 sites in CONUS that would require 150 km radius effective 5G exclusion zones
- Finally, proposes stringent OOB emission requirements for 5G terrestrial user equipment

Simulation of CBA's Proposed RF Regime in Miami Market

1. **The CBA's radio frequency regime proposal would have significant impact on 5G network architecture**
   - Proposed rules would impact base stations up to 1.5 miles from any protected earth station
   - In the Miami market, that would impact 5G deployment serving a population of as much as 1.4 million, or 24% of the market
2. **Would require extensive site specific re-engineering design adding cost and complexity to an organic network expansion**
   - In-band thresholds would be surpassed at 18% of FSS earth stations in database & OOB thresholds would be surpassed at 42% of FSS earth stations
3. **CBA's proposed 150 m protection zone around each registered station significantly expands this complexity and corresponding costs**
   - In-band thresholds would be surpassed at 33% of FSS earth stations in database & OOB thresholds would be surpassed at 60% of FSS earth stations
4. **CBA's proposed aggregate interference threshold rules for base stations within 40 km of an FSS earth station offer little to no additional protection for FSS earth stations yet adds considerable complexity and coordination risks for timely 5G deployment**
5. **All of this complexity is directly proportional to the total number of FSS earth stations that would need to be protected**

AT&T's Proposal: A More Efficient C-Band Spectrum Use

AT&T's Proposal



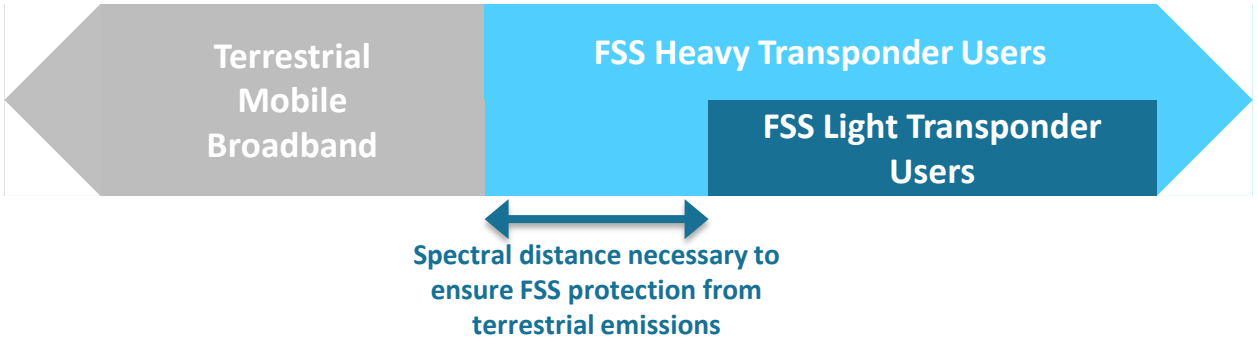
- **No fallow guard band**
- **Full power (Part 27) rules should apply to majority of flexible use cleared spectrum**
  - FSS earth station protection is achieved via spectral separation
- **Adjacent terrestrial licenses immediately below the FSS band edge should be subject to lower power constraints or coordination requirements aimed to protect FSS earth stations**
- **Terrestrial & FSS vendor community must work together to determine appropriate size of the Adjacent Licenses**
  - Preliminary results suggest a range between 30-50 MHz
  - Highly sensitive to FSS OOB protection criteria
  - Also highly sensitive to the design of 5G base station filters & FSS receive filters

AT&T Additionally Proposes

- **Investigate less restrictive alternatives than a blanket 150-meter radius protection zone around each FSS earth stations**
  - FCC's efforts to update the C-band IBFS registered database should ensure we understand what the universe of FSS earth station actually is – no need for buffer zones for non-existent earth stations
- **Reject the proposed aggregate interference threshold from base stations within 40 km from an FSS earth station**
  - Simulation has shown that it is a single dominant interferer that drives the interference power received, not aggregate interference
- **Develop further the record to examine the appropriate definition of satellite full arc required for protection of actual C-band use post-transition**
  - Instead explore efficiency gains from defining full arc protection and earth station elevation angles to ranges that represent actual C-band use within CONUS for any given earth station location (or market)

AT&T Additionally Proposes

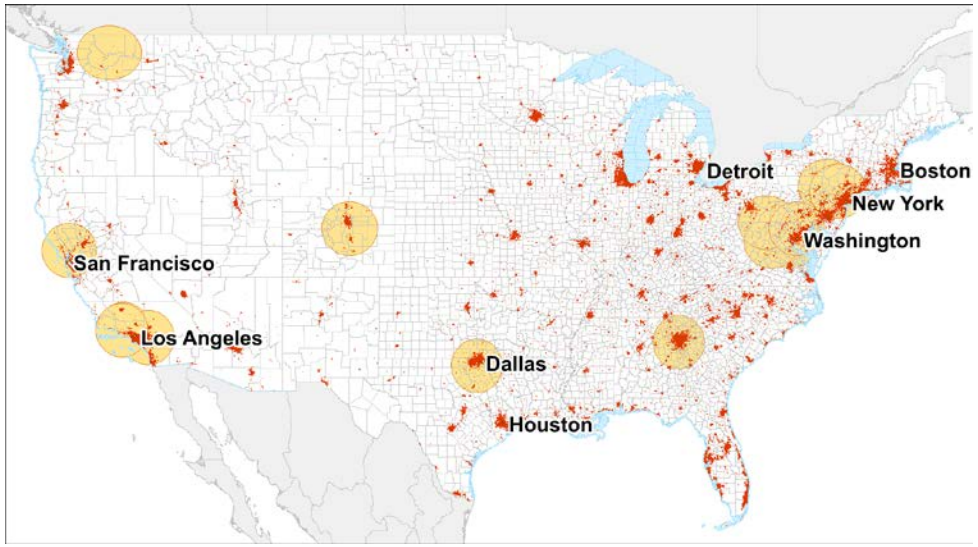
- **Explore efficiencies gained from repacking low transponder-need applications to the upper edge of the FSS band thus allowing for sufficient spectral distance from the 5G blocks to ensure protection from terrestrial emissions**



- According to CBA, 68% of registered FSS earth stations support applications such as radio broadcasters, religious broadcasters and others which likely have light transponder capacity use
- Repacking these applications to the upper edge of the FSS band would achieve sufficient spectral distance from the 5G edge to ensure full FSS protection from terrestrial emissions, eliminating the need for coordination of the terrestrial licenses
- This strategy would support FSS demand while drastically reducing the number of earth station locations that would need to be protected by 5G licensees – possibly by a factor of 10 – significantly lowering costs and timeframes of 5G deployment

Telemetry, Tracking & Control CONUS Sites

- **Further detail is required to determine an efficient approach to protect TT&C sites**
  - What are the remaining 4 sites where CBA proposes a 70,000 km^2 5G exclusion zone?
  - What are the channels in use at each of these 4 sites for TT&C?
  - Can TT&C teleports be relocated to areas outside CONUS or to low population areas within CONUS?
  - What TT&C plans exist for future C-band satellites?
  - Why should quality control of payloads serving non-CONUS areas be monitored from CONUS?



5G User Equipment OOB Emission Limits

- **CBA's proposed OOB emission limits for 5G user equipment (UE) are too stringent**
  - The proposed thresholds for UEs are significantly more stringent than those proposed for base stations on the band, and more stringent than both Part 27 and Part 90 rules, presenting significant complexity to the 5G ecosystem on the band
  - Qualcomm notes that "those limits would require massive reductions in mobile transmit power levels and thus cripple U.S. deployment of 5G technology in this band" as well as "destroy any economies of scale and any worldwide harmonization for devices that use this band"
  - The Commission should reject this proposal and encourage industry stakeholders to collaborate to develop user equipment OOB emission limits recommendations that would enable both 5G services on the band and protection of FSS earth stations

BACKGROUND MATERIALS

C-Band Fixed Satellite Service/5G Co-Existence Analysis – Miami, FL

AT&T Inc.

Commscope

June 2019

Objective & Conclusions

Objective

Evaluate the impact of CBA Fixed Satellite Service ("FSS") coordination proposal* on an existing AT&T network grid layout using Miami, FL as a sample market

Simulate and study both In-Band and Out-of-Band ("OOB") interference modes

Conclusion

20 MHz guard band proposed by CBA is not adequate

Current CBA proposal significantly constrains 5G deployments

Study is ongoing and additional markets will be evaluated that provide a different perspective on geography and look angles on the U.S. satellite arc

* Coordination proposal based on CBA Reply Comments, GN Docket 18-122 (filed Dec. 11, 2018)

CBA Proposed C-band FSS Protection Req’ts

CBA proposal would aggregate radiofrequency (RF) power density at the output of a reference RF filter and antenna of an FSS earth station produced by emissions from all Fixed and Base Stations of a 5G licensee within 40 kilometers:

- For in-band emissions, the RF power density “shall not exceed a value of -81.6 dBm/MHz in the band 3700-3900 MHz”
- For OOB emissions in the FSS band, the RF power density “shall not exceed a value of -133 dBm/MHz for earth stations used for satellite [TT&C] operations and -128 dBm/MHz for other earth stations.”

The protection requirement must be complied with:

- “for any pointing of the antenna towards the [GSO] arc with an elevation angle greater than or equal to 5 degrees” and
- “for all earth station antennas within a radius of 150 meters of the location of the registered earth station.”

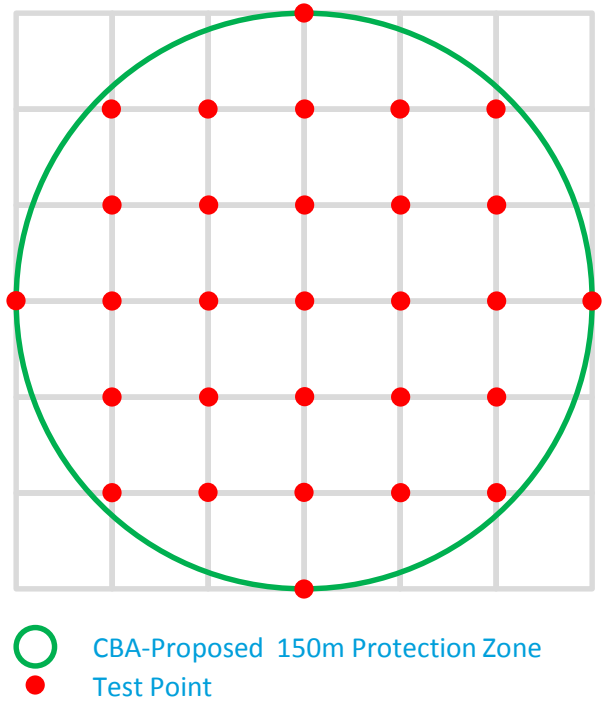
Simulation Assumptions

Propagation model and protection methodology identical to FCC-approved CBRS model for adjacent spectrum

- NTIA ITS Irregular Terrain Model (ITM) (Longley-Rice) (20MHz-20 GHz) model in point-to-point mode
- CBA proposed an FSS antenna pattern similar to the 25.209 rules

Protection assessed for 150m radius around registered ES

- A 50m x 50m grid is generated for the area around each registered ES
- Protection requirements assessed at each grid point within 150m radius



Simulation Assumptions (Cont'd)

Used extreme satellite arc positions at 18° W and 139° W*

- ES antenna azimuth angle is a key factor, with antenna elevation, to determine receive (Rx) antenna gain.
- Where interference is close to the protection threshold, variations in the Rx antenna gain could cause thresholds to be exceeded; further work will be conducted to evaluate the impact over the entire satellite arc.

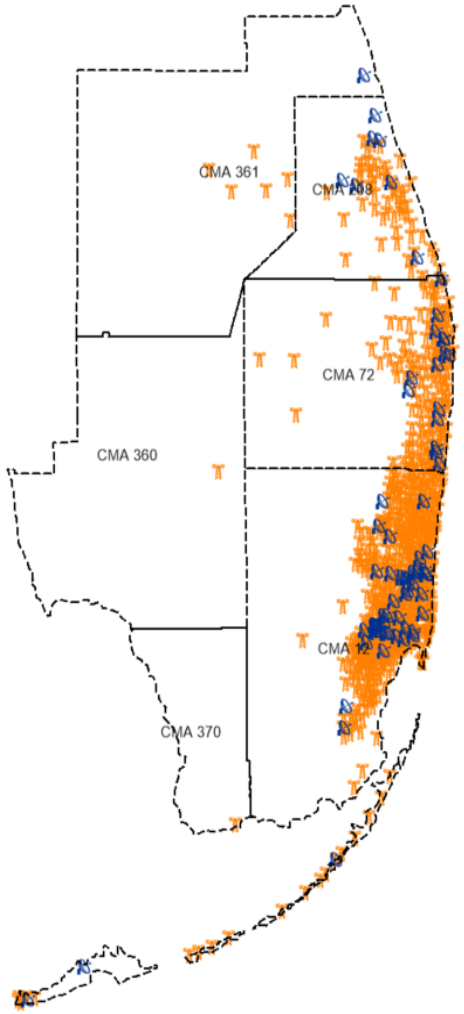
ES Reference Antenna Mask	
G = 52.6 dBi	for $0^\circ \le \varphi < 1.5^\circ$
G = 2 - 25 log φ dBi	for $1.5^\circ \le \varphi < 7^\circ$
G = 8 dBi	for $7^\circ \le \varphi < 9.2^\circ$
G = 32 - 25 log φ dBi	for $9.2^\circ \le \varphi < 48^\circ$
G = -10 dBi	for $48^\circ \le \varphi \le 180^\circ$

* The 18° W and 139° W limits were derived by considering only FCC authorized space stations for C-band GSO FSS operations that would have resulted in look angles no less than the 5° specified by the CBA for the Miami area.

5G Network Parameters

Used AT&T Miami market grid layout

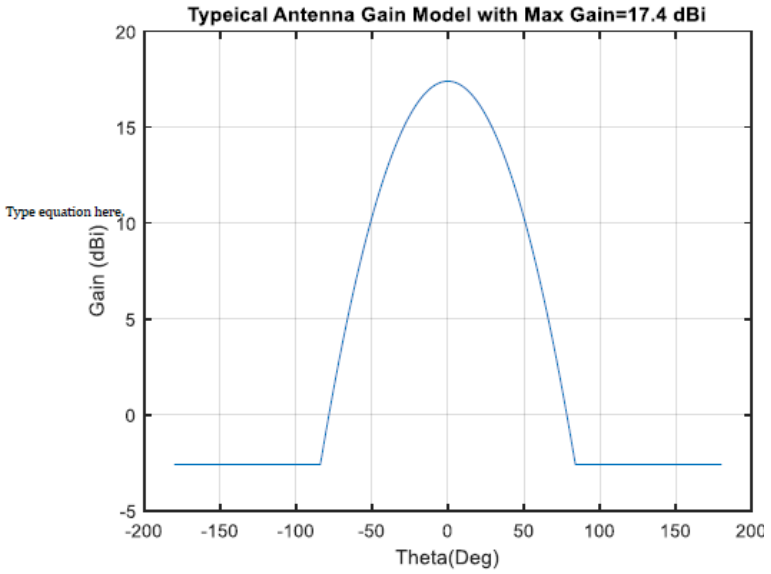
- Included 2000+ sectors belonging to urban, suburban & rural site geographies
- Base station heights ranged from 10 to 300 ft
- Sector orientations ranged from 0 to 357 degrees North
- 78 unique FSS earth station (ES) locations analyzed, using the 40 km “neighborhood” defined by CBA



5G Network Parameters (Cont'd)

The study assumed FCC Part 27 parameters:

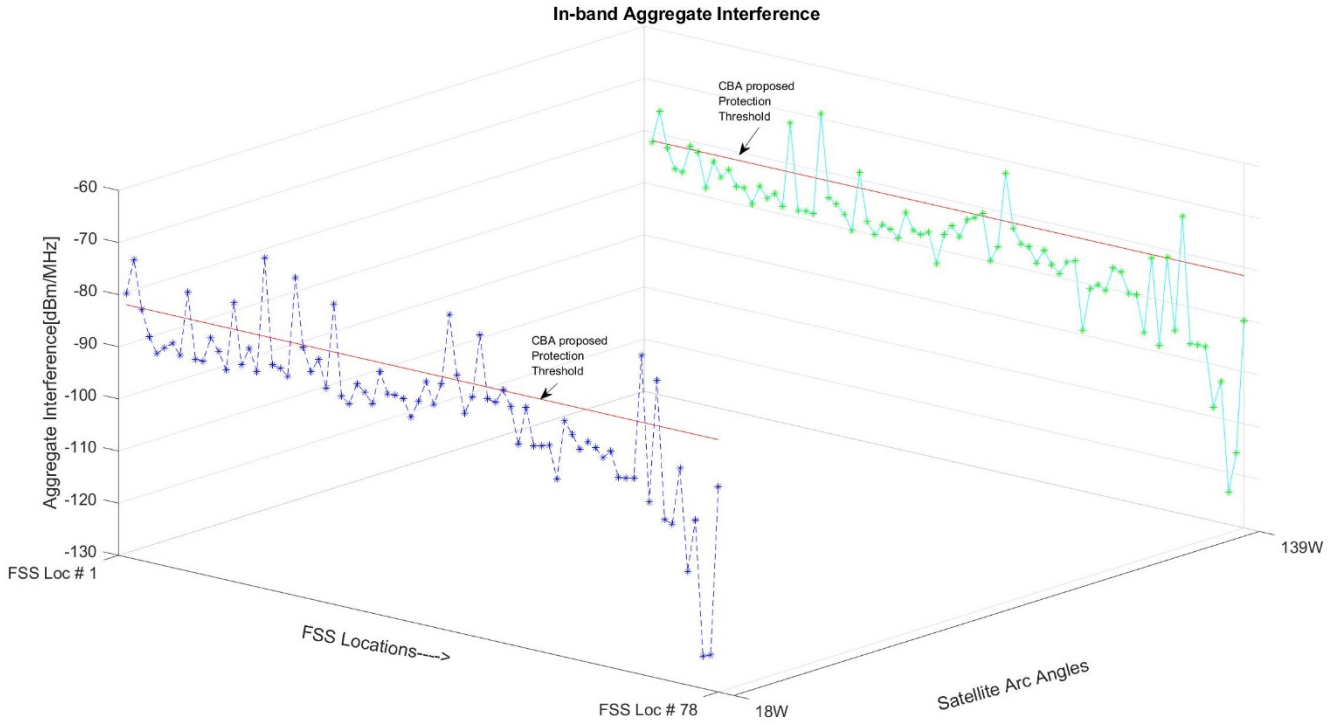
- Base Station EIRP is 75 dBm/10 MHz channel (65 dBm/MHz) in rural areas
- Base Station EIRP is 72 dBm/10 MHz channel (62 dBm/MHz) in other areas
- 65° antenna beamwidth and antenna pattern consistent with current CBRS modeling and AT&T network
- 10 MHz carrier adjacent to CBA-specified 20 MHz guard band (*i.e.*, 20 MHz offset from FSS band edge)



$$G(\theta) = -min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, \quad A_H\right] \ (dBi)$$

$$Gain(\theta) = G(\theta) + MaxGain$$

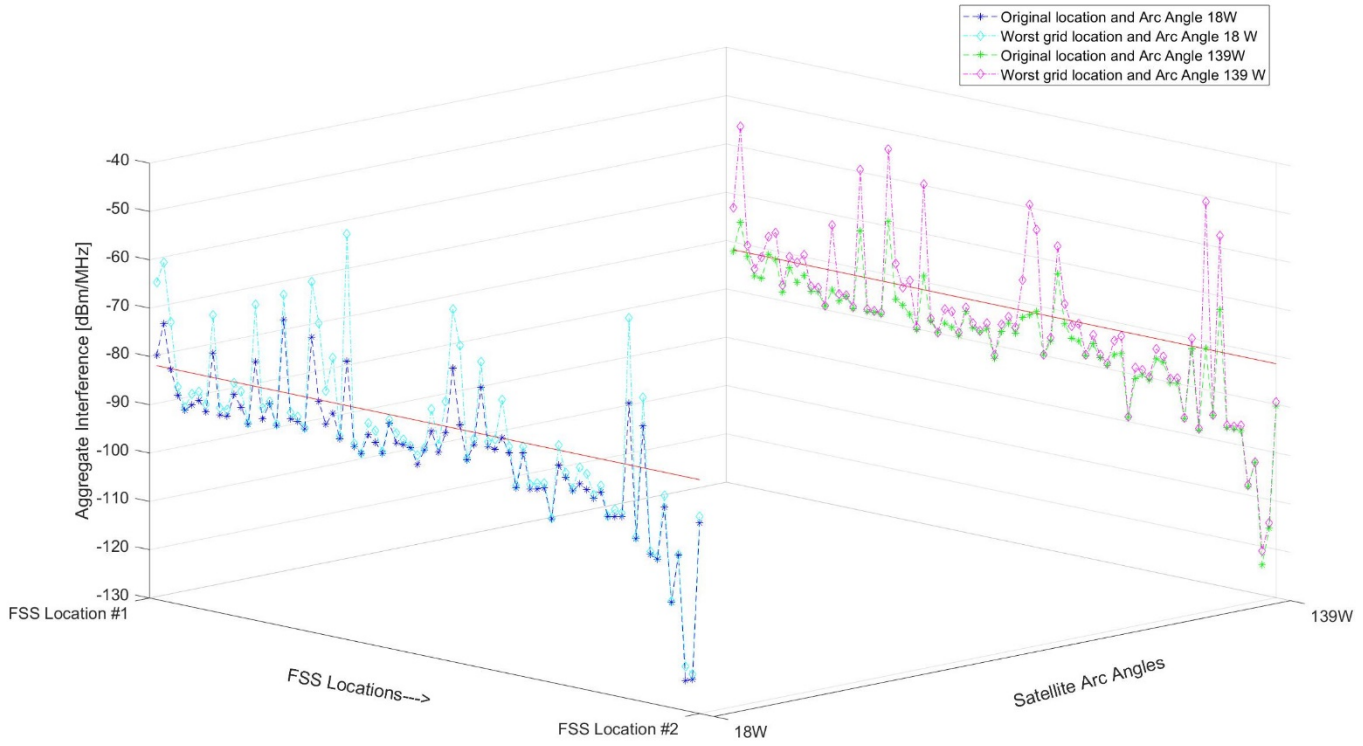
In-Band Interference Testing Results



The aggregate mean interference from BS crosses the CBA-proposed threshold in 14 out of 78 FSS ES locations analyzed

The CBA-proposed threshold is exceeded at 17.9% of ES locations

In-Band Interference Testing Results w/150m Radius Protection Zone



The aggregate mean interference from BS crosses the CBA-proposed threshold in 26 out of 78 FSS ES protection zones analyzed

The CBA-proposed threshold is exceeded at 33.3% of FSS protection zones

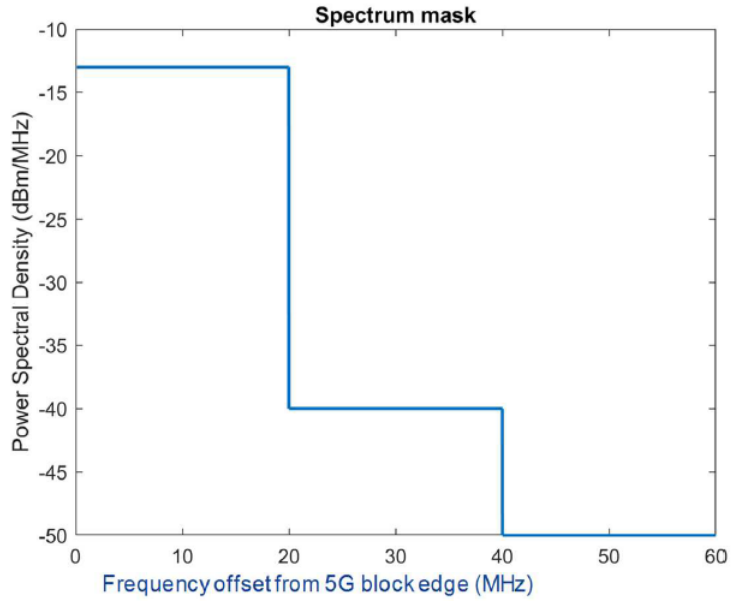
Additional Assumptions for OOB Analysis

OOB Analysis uses an emission mask based on CBA filing

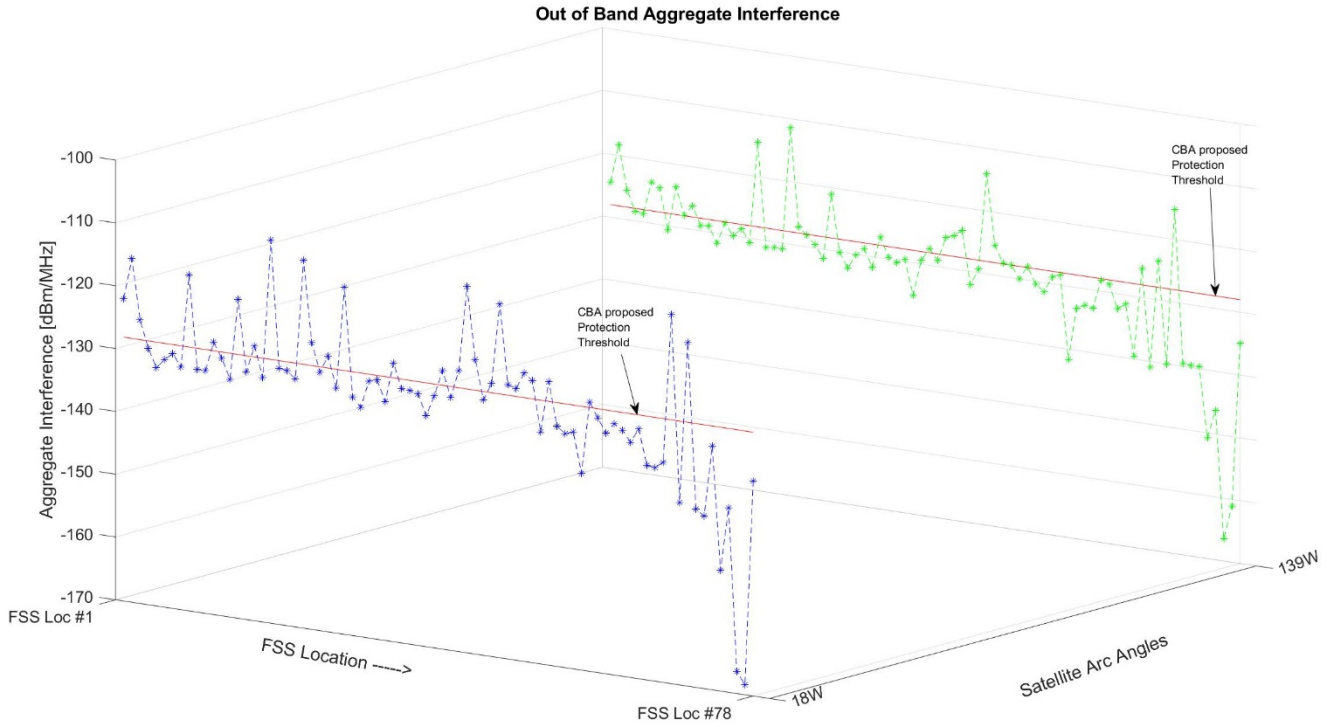
- -13dBm/MHz from 0 to 20 MHz frequency offset
- -40 dBm/MHz from 20 to 40 MHz frequency offset
- -50 dBm/MHz for frequency offsets greater than 40 MHz

Base Station OOB emission power into the FSS passband is -40 dBm/MHz

- Used OOB threshold of -128 dBm/MHz used
- Does not implement added CBA-proposed protection for TT&C ES locations where more stringent requirement (-133 dBm/MHz) would apply



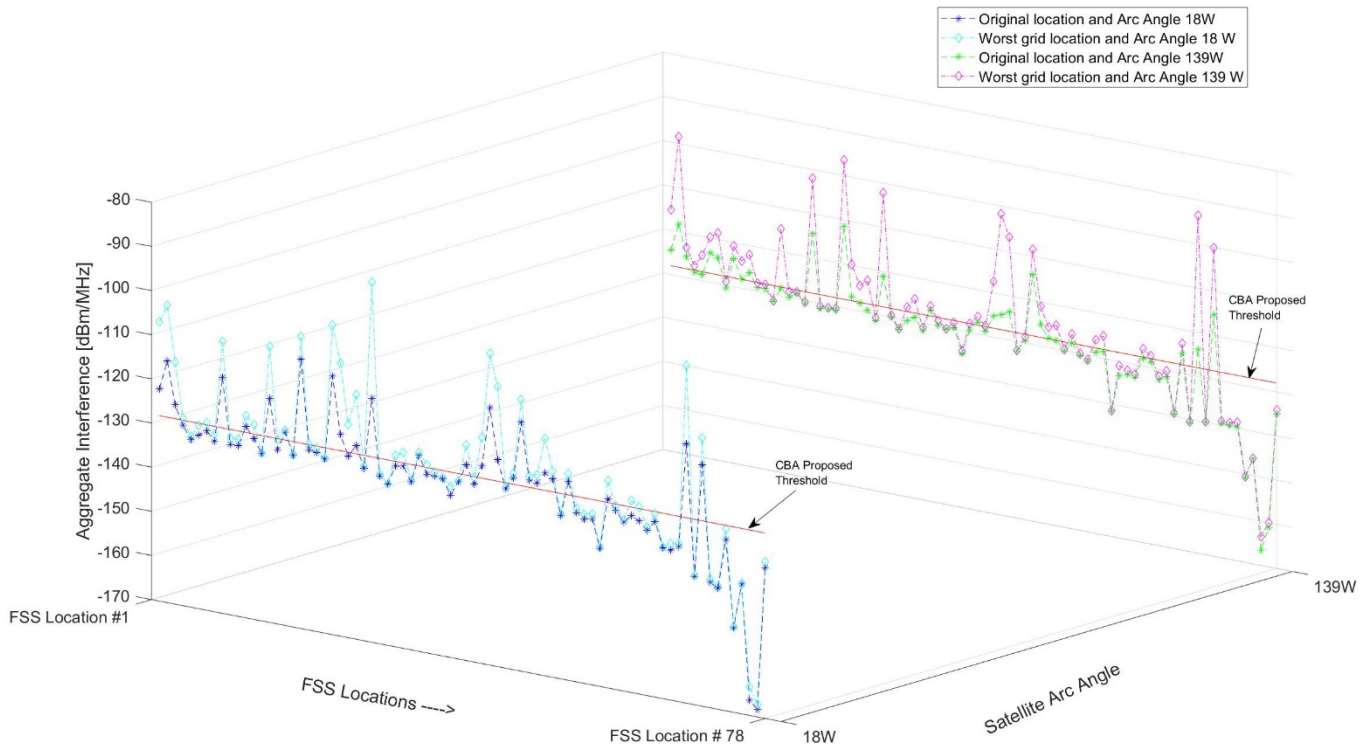
OOB Interference Testing Results



The aggregate mean interference from BS crosses the CBA-proposed threshold in 33 out of 78 FSS ES locations analyzed

The CBA-proposed threshold is exceeded at 42.3% of ES locations

OOB Interference Testing Results w/150m Radius Protection Zone



The aggregate mean interference from BS crosses the CBA-proposed threshold in 47 out of 78 FSS ES protection zones analyzed

The CBA-proposed threshold is exceeded at 60.3% of FSS protection zones

In Depth Review of ES Locations

Analyzed FSS ES locations where in-band/out-of-band thresholds exceeded

- Representative situations, not worst or best case
- Goal is identification of cause of high mean aggregate interference at FSS

Three locations analyzed

A single dominant interferer uses most of the protection margin and therefore aggregation cap is unnecessary and complex rule

In Depth Review ES Location 1

Viacom Services Corp.

Callsign E090157

25.9240, -80.2180

4.5m antenna height

1342 impacting BS locations

	Sat. Arc Pos.: 18° W Az: 102.9702° El: 16.4426°	Sat. Arc Pos.: 139° W Az: 255.1603° El: 19.5911°
Aggregate Power In- Band, dBm	- 66.5671	- 72.1264
Aggregate Power OOB, dBm	- 108.9661	- 114.5235

Registered Earth Station Location

Fixed/Base Station site

Azimuth direction for the Earth Station Antenna for the given Satellite arc positions

Azimuth direction for one of the Base Station at the site location

In Depth Review ES Location 1

	Sat. Arc Pos.: 18° W Az: 102.9703° El: 16.4426°	Sat. Arc Pos.: 139° W Az: 255.1603° El: 19.5911°
Mean Power In-Band, dBm	-66.7108	-72.3276
Mean Power OOB, dBm	-109.1108	-114.7276

BS w/greatest impact

25.9242, -80.2174

Antenna Height: 29.5732m

Antenna Azimuth: 230°

EIRP: 62 dBm/M··

Antenna Gain: 1

	5G BS Tx Power (dBm)	Path Loss (dB)	5G BS Antenna Gain (dBi)	FSS RF Filter Attenuation (dB)	FSS ES Rx Antenna Gain (dBi)	In-Band Median Power (dBm)
Sat. Arc Pos.: 18° W Az: 102.9702° El: 16.4426°	44.4	-79.7524	16.0689	-43	-4.3832	-66.6667
Sat. Arc Pos.: 139° W Az: 255.1603° El: 19.5911°	44.4	-79.7524	16.0689	-43	-10	-72.2835

	5G BS Tx Power (dBm)	Path Loss (dB)	5G BS Antenna Gain (dBi)	FSS RF Filter Attenuation (dB)	FSS ES Rx Antenna Gain (dBi)	OOB Median Power (dBm)
Sat. Arc Pos.: 18° W Az: 102.9702° El: 16.4426°	-40	-79.7524	16.0689	-1	-4.3832	-109.0667
Sat. Arc Pos.: 139° W Az: 255.1603° El: 19.5911°	-40	-79.7524	16.0689	-1	-10	-114.6835

In Depth Review ES Location 2

CBS Television Stations, Inc.

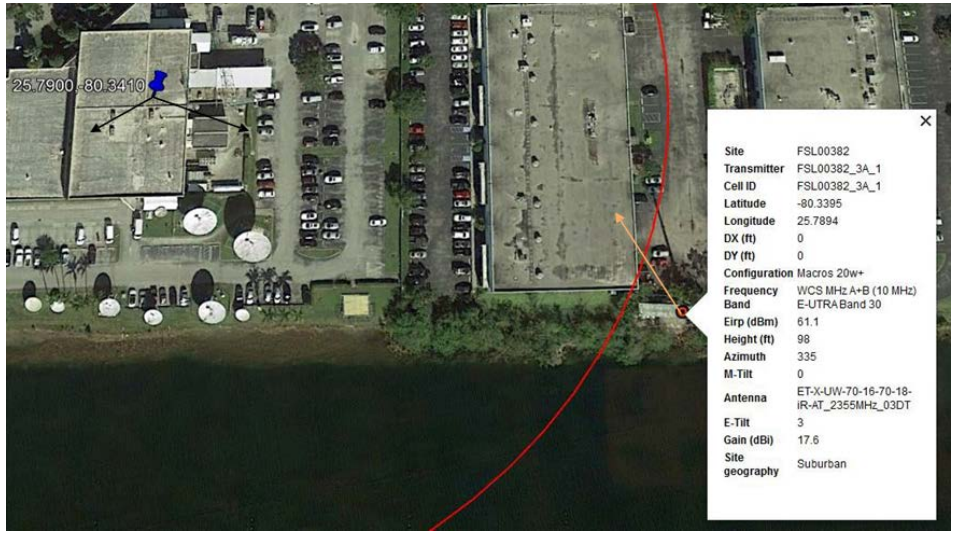
Callsign E8359

25.7900N, -80.3410W

5m antenna height

1181 impacting BS locations

	Sat. Arc Pos.: 18° W Az: 102.8451° El: 16.3611°	Sat. Arc Pos.: 139° W Az: 255.1601° El: 19.7400°
Aggregate Power In- Band, dBm	- 69.3013	- 82.1932
Aggregate Power OOB, dBm	- 111.7006	- 124.6591



Registered Earth Station Location

Fixed/Base Station site

Azimuth direction for the Earth Station Antenna for the given Satellite arc positions

Azimuth direction for one of the Base Station at the site location

In Depth Review ES Location 2

	Sat. Arc Pos.: 18° W Az: 102.8451° El: 16.3611°	Sat. Arc Pos.: 139° W Az: 255.1601° El: 19.7400°
Mean Power In-Band, dBm	-69.7507	-83.9139
Mean Power OOB, dBm	-112.1507	-126.3139

BS w/greatest impact

25.7894, -80.3395

Antenna Height: 29.8780m

Antenna Azimuth: 335°

EIRP: 62 dBm/M··

Antenna Gain: 1

	5G BS Tx Power (dBm)	Path Loss (dB)	5G BS Antenna Gain (dBi)	FSS RF Filter Attenuation (dB)	FSS ES Rx Antenna Gain (dBi)	In-Band Median Power (dBm)
Sat. Arc Pos.: 18° W Az: 102.8451° El: 16.3611°	44.4	-87.919	12.6492	-43	4.1632	-69.7066
Sat. Arc Pos.: 139° W Az: 255.1601° El: 19.7400°	44.4	-87.919	12.6492	-43	-10	-83.8698

	5G BS Tx Power (dBm)	Path Loss (dB)	5G BS Antenna Gain (dBi)	FSS RF Filter Attenuation (dB)	FSS ES Rx Antenna Gain (dBi)	OOB Median Power (dBm)
Sat. Arc Pos.: 18° W Az: 102.8451° El: 16.3611°	-40	-87.919	12.6492	-1	14.2744	-46.7364
Sat. Arc Pos.: 139° W Az: 255.1601° El: 19.7400°	-40	-87.919	12.6492	-1	-10	-71.0108

In Depth Review Loc. 3 w/150m Protection Zone

Salem Comm. Hldg Corp.

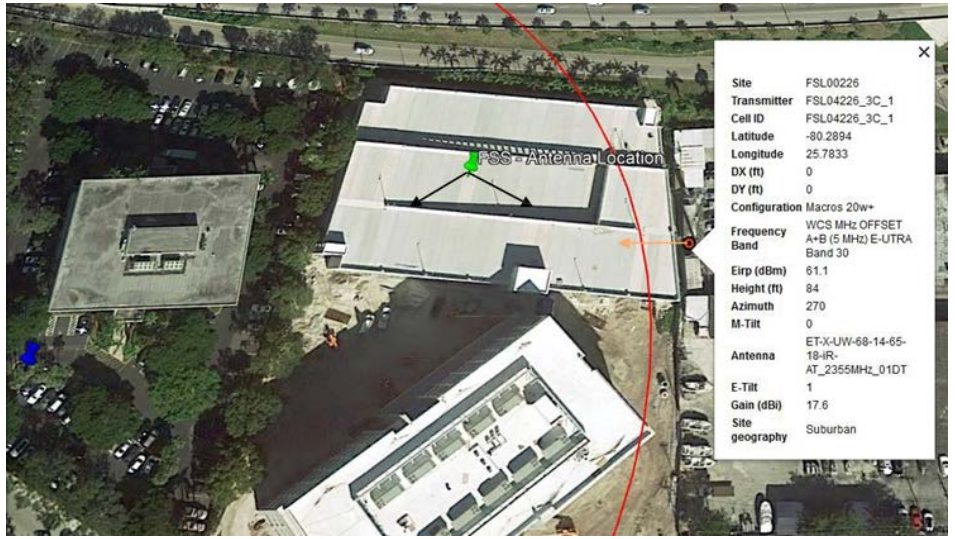
Callsign E181290

25.7835N, -80.2900W

3.8m antenna height

1182 impacting BS locations

	Sat. Arc Pos.: 18° W Az: 102.8451° El: 16.3611°	Sat. Arc Pos.: 139° W Az: 255.1601° El: 19.7400°
Mean Power In- Band, dBm	- 69.7507	- 83.9139
Mean Power OOB, dBm	- 112.1507	- 126.3139



 Registered Earth Station Location

 Fixed/Base Station site

Azimuth direction for the Earth Station Antenna for the given Satellite arc positions

Azimuth direction for one of the Base Station at the site location

In Depth Review Loc. 3 w/150m Protection Zone

	Sat. Arc Pos.: 18° W Az: 102.8690° El: 16.4094°	Sat. Arc Pos.: 139° W Az: 255.1919° El: 19.6950°
Mean Power In- Band, dBm	- 46.7805	- 71.0549
Mean Power OOB, dBm	- 89.1805	- 113.4549

BS w/greatest impact

25.7833, -80.2894

Antenna Height: 25.6098m

Antenna Azimuth: 270°

EIRP: 62 dBm/M··

Antenna Gain: 1

	5G BS Tx Power (dBm)	Path Loss (dB)	5G BS Antenna Gain (dBi)	FSS RF Filter Attenuation (dB)	FSS ES Rx Antenna Gain (dBi)	In- Band Median Power (dBm)
Sat. Arc Pos.: 18° W Az: 102.8690° El: 16.4094°	44.4	-79.3407	16.9299	-43	14.2744	-89.1364
Sat. Arc Pos.: 139° W Az: 255.1919° El: 19.6950°	44.4	-79.3407	16.9299	-43	-10	-113.4108

	5G BS Tx Power (dBm)	Path Loss (dB)	5G BS Antenna Gain (dBi)	FSS RF Filter Attenuation (dB)	FSS ES Rx Antenna Gain (dBi)	OOB Median Power (dBm)
Sat. Arc Pos.: 18° W Az: 102.8690° El: 16.4094°	-40	-79.3407	16.9299	-1	4.1632	-112.1066
Look Angle: 139° W Az: 255.1919° El: 19.6950°	-40	-79.3407	16.9299	-1	-10	-126.2698